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# Phytoplankton Diversity and Dynamics of Balua Floodplain Lake (*Chaur* ), Muzaffarpur, Bihar, India – A Seasonal Study

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## Abstract

A study was carried out in Balua floodplain lake (*chaur*), Muzaffarpur, Bihar, India on phytoplankton diversity, density and distribution in different seasons and their correlation with physic-chemical properties of water. Seasonal distribution pattern of phytoplankton density revealed to be the highest in post monsoon, followed by pre-monsoon and monsoon. The Euglenophyceae class of plankton was found significantly highest ($p<0.05$) and Bacilariophyceae class of plankton was found significantly lowest ($p<0.05$) among all other class of plankton studies during post monsoon, pre monsoon as well as monsoon season. Among physic-chemical parameters, transparency and dissolve oxygen (DO) were found significantly ($p<0.05$) highest in post monsoon season whereas significantly ($p<0.05$) lowest in monsoon season. Free $CO_2$ total alkalinity, biological oxygen demand (BOD) and chemical oxygen demand (COD) were found significantly ($p<0.05$) highest in monsoon season whereas significantly ($p<0.05$) lowest in post monsoon season. Total phytoplankton density showed significantly positive correlation with transparency and calcium. This study revealed that the physic-chemical parameters of Balua floodplain lake (*chaur*) is within limit range and the lake has a great aquaculture potential and total phytoplankton density showed significantly positive correlation with transparency and calcium. These types of studies are prerequisites for evolving fish culture programmes and management of water resources.

**Keywords:** Balua floodplain lake, phytoplankton, post monsoon, pre monsoon, monsoon, physic-chemical parameters.

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## INTRODUCTION

The floodplain lakes are the flatland bordering the rivers, which are inunded with flooded water and tend to expand along

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with lower stretches of rivers. These waterbodies are rainfed shallow low lying water areas and characterised by poor drainage and prolonged water logging. These natural ecosystems expand and contract with response to flood and drought and have close relationship with mankind since their inception. *Chaurs* provide water for irrigation besides serving as habitat of aquatic organism and migratory birds and maintaining the aquatic biodiversity. Besides providing vital breeding and nursery ground to numerous riverine fish species, it also controls many environmental functions viz. maintenance of stability in low land ecosystem, effective flood water retention and recharging of ground water.

Floodplain lake represent lucrative areas for fisheries in many states of Eastern U.P, Northern Bihar, West Bengal, Assam and Manipur and contribute significantly to the inland fisheries to the country. Bihar lying in the heart of Gangetic plains, is blessed with fertile land resources through extreme hot and cold climatic conditions along with flood and drought situations which are the characteristic part of its geography. The floodplains are mainly located in north east part of Bihar and created by frequent shift in river course originating from Himalayas in Nepal and among them Ghagra, Gandak, Burhi Gandak, Bagmati, Kamlabalan and koshi are most significant. These waterbidies occupies important position in inland fisheries of Bihar because of their magnitude as well as productive potential.

Diversity, distribution, abundance and variation in the biotic factors provide information of energy turnover in the aquatic systems (Forsberg, 1982). In these systems phytoplankton is of great importance as a major source of organic carbon located at the base (Gaikwad *et. al.,* 2004). Their sensitivity and large variations in species composition are often a reflection of significant alteration in ambient condition within an ecosystem (Devassy and Goes, 1988 & 1989). Hence for any scientific utilization of water resources plankton study is of primary interest. Several studies on phytoplankton diversity made in India and abroad on the ponds, lake and reservoirs (Tiwari and Chauhan, 2006; Sridhar *et. al.,* 2006; Tas and Gonulol, 2007; Senthilkumar and Sivakumar, 2008, Laskar and Gupta, 2009) also revealed the importance of this type of study. In this paper an attempt has been made to study seasonal variation of phytoplankton diversity and dynamics of a part of Balua floodplain lake (*chaur*) and its correlation with the physico-chemical properties of water.

## MATERIAL AND METHODS

The study was conducted in the Balua chaur, located about 1 Km east of College of Fisheries, Dholi, Muzaffarpur and 8 Km west to Rajendra Agricultural Unibersity, Pusa (Samastipur), Bihar.

Phytoplankton and water samples were collected in post monsoon (October – January), pre monsoon (February – May) and monsoon (June – September) from three sampling sites, selected for the study of Balua chaur. Samples were collected fortnightly for a period of one year (October 2008 to September 2009).

The water samples were collected between 8.00 A.M and 10.00 A.M in properly washed 1.5 litre capacity plastic sampling bottles at the depth of 25-30 cm from water surface. Water temperature, pH, transpar-

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ency, dissolved oxygen and total alkalinity content were monitored at the sampling spot while Free $CO_2$, chloride, calcium, nitrate, phosphate, silicate, biological oxygen demand (BOD) and chemical oxygen demand (COD) were analyzed in the laboratory in accordance with Welch (1948) and APHA (2005). Qualitative and quantitative estimation of phytoplankton from each site was carried out with the help of "Sedgwick Rafter" counting cell and identified using standard literature (Edmondson,1959; Anand, 1998).

The average (mean ± SE) for each parameter per month was computed, considering the values from three spots. The significant difference, if any, in the mean values of each parameter of twelve months was determined by one way ANOVA, followed by Duncan's new multiple range test (DMRT). The Pearson correlation co-efficient was used to examine the relationship among the different environmental variables including phytoplankton density. The linear regression model was performed using SPSS 12.

## RESULTS AND DISCUSSION

It is an established fact that maintenance of healthy aquatic ecosystem is dependent on the physico-chemical properties of water and biological diversity. The biological spectrum of the lentic fresh water bodies is multidimensional where phytoplankton where phytoplankton are useful in biomonitoring the ecological disturbance caused by several physico-chemical factors.

Seasonal distribution pattern of phytoplankton density revealed to be the highest in post monsoon, followed by pre-monsoon and monsoon (Table 1). In the chatla floodplain lake, Brak Valley, Assam, the abundance of phytoplankton was found highest in post monsoon period (Laskar and Gupta, 2009). The Euglenophyceae class of plankton was found significantly highest ($p<0.05$) and Bacilariophyceae class of plankton was found significantly lowest ($p<0.05$) among all other class of plankton studies during post monsoon, pre monsoon as well as monsoon season. The Chlorophyceae class of plankton was found significantly highest ($p<0.05$) in post monsoon season whereas Cyanophyceae in pre monsoon season. The Euglenophyceae and Bacilariophyceae class of plankton was found significantly lowest ($p<0.05$) in monsoon season whereas significantly highest ($p<0.05$) in post monsoon season which was similar in pre monsoon. The value of physio-chemical parameters studied during different seasons are given in Table 2 and the Pearson correlation matrix of different physio-chemical variables including total phytoplankton density is depicted in Table 3.

Significantly highest ($p<0.05$) DO was recorded in post monsoon and similar during pre monsoon and monsoon season. Water temperature was significantly highest ($p<0.05$) in monsoon followed by pre monsoon and significantly lowest ($p<0.05$) in post monsoon. It showed significant negative relationship of water temperature with DO. Highest DO during post monsoon could be attributed to the fact that in lower temperature oxygen carring capacity of water increases (Wetzel, 1983; Desai *et. al.,* 1995). Dissolve oxygen showed significant negative correlation with $CO_2$, BOD and COD. $CO_2$, BOD and COD also showed significant positive re-

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lationship with each other (Table 3). During monsoon surface runoff carries waste and sewage from the surrounding areas into the lowlying beds of the floodplain lakes, thereby increasing the respiratory activity of the heterotrophic organism (Singhal *et. al.,* 1986) this might be the reason of lowest DO and highest $CO_2$, BOD and COD values in monsoon.

The average pH of the floodplain ranged between 7.60 to 7.72, indicating the system to be alkanotrophic in nature (Bhaumik *et. al.,* 2003). The narrow range of pH indicated stability as most of the aquatic organism are adapted to an average pH and do not withstand abrupt changes (George, 1997).

The total alkalinity was significantly highest ($p<0.05$) during post monsoon followed by pre monsoon then significantly lowest ($p<0.05$) in monsoon. The highest phytoplankton density (Table 2) during post monsoon could be linked to this as natural waters containing 40 mg l-1 or more total alkalinity are more productive (Manna and Das, 2004). During monsoon, fertilizers etc. from the surrounding agricultural field accumulate in the system and subsequentl drying during post monsoon might have contributed to the highest alkalinity.

Simple linear regression showed highly significant positive correlation of phytoplankton density with transparency ($r = 0.79$, $p<0.05$) (Figure 1). In this study, total phytoplankton density showed positive correlation with calcium ($r = 0.67$, $p<0.05$) (Figure 2) could be attributed to the fact that calcium is an important part of plant tissue, increases the availability of other ions, reduces the toxic effect of $NO_2$ – N (Manna and Das, 2004) and thus might have played a vital role in the growth of phytoplankton. Further studies on the Euglena bloom in the same area (Dutta gupta *et. al.,* 2004, Bhuiyan and Gupta, 2007) and another study on lake Manasbal of Kasmir valey of India (Khan an Bhat, 2000) emphasized the importance of calcium in stimulating the growth of Euglena.

Seasonal variations in the density of different groups of phytoplankton is depicted in Table 1. The density of Chlorophyceae, Euglenophyceae and Bacilariophyceae was found highest during post monsoon and lowest in monsoon season. The density and cyanophyceae was highest during pre monsoon followed by post monsoon and then monsoon season.

The percentage composition of seasonal distribution of phytoplankton is represented in Table 4. In post monsoon, Euglenophyceae was the most dominant group followed by Chlorohyceae, Cyanophyceae and Bacilariophyceae (Table 4). Similar trend was found in monsoon season also whereas in pre monsoon, the most dominant group of phytoplankton was Euglenophyceae followed by Cyanophyceae, Chlorophyceae and Bacilariophyceae.

Conclusively, our study revealed that facts governed the growth of phytoplankton are transparency and calcium. The physicchemical parameters of Balua floodplain lake (*chaur*) is within limit range and the lake has a great aquaculture potential. These types of studies are prerequisites for evolving fish culture programmes and management of water resources.

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ies, Dholi, Bihar for providing necessary laboratory facilities.

**Table 1**

**Seasonal variation in the density (Mean ± SE) of different groups of phytoplankton (ul-1) in Balua Chaur during October 2008 to September 2009.**

| Phytoplankton classes | Post Monsoon 2008-09 | Pre Monsoon 2009 | Monsoon 2009 |
|---|---|---|---|
| Chlorophyceae | $101.50^{a} \pm 9.35$ | $80.00^{b} \pm 6.45$ | $63.75^{b} \pm 5.62$ |
| Cyanophyceae | $90.00^{b} \pm 7.42$ | $108.75^{a} \pm 9.15$ | $35.50^{c} \pm 2.73$ |
| Euglenophyceae | $155.50^{a} \pm 13.72$ | $158.25^{a} \pm 14.86$ | $60.00^{b} \pm 5.28$ |
| Bacilariophyceae | $68.00^{a} \pm 5.94$ | $56.75^{a} \pm 4.75$ | $25.75^{b} \pm 2.74$ |
| **Total Phytoplankton** | **103.75 ± 9.27** | **100.94 ± 8.52** | **46.25 ± 4.25** |

**Table 2**

**Physical and chemical characteristics (Mean ± SE) of water in Balua Chaur during October 2008 to September 2009.**

| Parameters | Post Monsoon 2008-09 | Pre Monsoon 2009 | Monsoon 2009 |
|---|---|---|---|
| Water Temperature | $21.60^{b} \pm 2.08$ | $26.75^{ab} \pm 2.31$ | $28.63^{a} \pm 2.36$ |
| Transparency | $34.50^{a} \pm 2.49$ | $34.75^{a} \pm 3.05$ | $30.50^{b} \pm 2.87$ |
| pH | $7.65^{a} \pm 0.67$ | $7.72^{a} \pm 0.47$ | $7.60^{a} \pm 0.67$ |
| DO | $7.75^{a} \pm 0.38$ | $7.25^{b} \pm 0.61$ | $7.20^{b} \pm 0.59$ |
| Free $CO_2$ | $0.38^{c} \pm 0.02$ | $1.95^{b} \pm 0.15$ | $2.56^{a} \pm 0.17$ |
| Total Alkalinity | $132.50^{ab} \pm 11.59$ | $101.50^{b} \pm 10.07$ | $145.00^{a} \pm 12.53$ |
| Calcium | $78.54^{b} \pm 2.46$ | $127.82^{a} \pm 11.26$ | $67.69^{b} \pm 5.28$ |
| Chloride | $3.67^{c} \pm 0.27$ | $8.69^{a} \pm 0.69$ | $5.82^{b} \pm 0.47$ |
| Nitrate | $0.41^{a} \pm 0.03$ | $0.22^{b} \pm 0.01$ | $0.43^{a} \pm 0.04$ |
| Phosphate | $0.08^{a} \pm 0.01$ | $0.13^{a} \pm 0.01$ | $0.12^{a} \pm 0.01$ |
| Silicate | $7.42^{b} \pm 0.81$ | $12.77^{a} \pm 1.04$ | $6.12^{b} \pm 0.52$ |
| BOD | $4.68^{b} \pm 0.27$ | $6.65^{a} \pm 0.62$ | $8.13^{a} \pm 0.63$ |
| COD | $6.80^{b} \pm 0.52$ | $12.15^{a} \pm 1.37$ | $13.88^{a} \pm 1.53$ |

**DO**: Dissolved oxygen, BOD: Biological Oxygen Demand, COD: Chemical Oxygen Demand

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**Table 3**

**Correlation matrix among the physico-chemical properties and phytoplankton density (ul-1) of the water of Balua *chaur* during October 2008 to September 2009.**

| Parameters | WT | TRNS | PH | DO | CO2 | TA | Ca | CHL | NIT | PHOS | SIL | BOD | COD | PHYTO |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WT | - | -0.58* | -0.13 | 0.69* | 0.74** | 0.53 | -0.08 | 0.59* | 0.07 | 0.76** | 0.12 | 0.69* | 0.75** | -0.37 |
| TRNS | | - | 0.46 | 0.53 | -0.56 | -0.61* | 0.21 | -0.25 | -0.37 | -0.61* | 0.20 | -0.70* | -0.68* | 0.79** |
| PH | | | - | -0.02 | 0.02 | -0.15 | 0.10 | -0.10 | -0.18 | -0.23 | -0.04 | -0.06 | -0.10 | 0.249 |
| DO | | | | - | -0.65* | -0.42 | -0.41 | -0.69 | 0.29 | -0.83** | -0.46 | -0.69* | -0.80** | 0.09 |
| CO2 | | | | | - | 0.28 | 0.14 | 0.58* | -0.24 | 0.61* | 0.18 | 0.80** | 0.83** | -0.35 |
| TA | | | | | | - | -0.11 | 0.37 | 0.38 | 0.53 | -0.08 | 0.34 | 0.32 | -0.35 |
| Ca | | | | | | | - | 0.66* | -0.86** | 0.34 | 0.91** | 0.22 | 0.34 | 0.45 |
| CHL | | | | | | | | - | -0.50 | 0.81** | 0.71** | 0.49 | 0.66* | 0.18 |
| NIT | | | | | | | | | - | -0.11 | -0.81** | -0.25 | -0.29 | -0.48 |
| PHOS | | | | | | | | | | - | 0.44 | 0.62* | 0.76** | -0.22 |
| SIL | | | | | | | | | | | - | 0.19 | 0.34 | 0.49 |
| BOD | | | | | | | | | | | | - | 0.94** | -0.61** |
| COD | | | | | | | | | | | | | - | -0.49 |
| PHYTO | | | | | | | | | | | | | | - |

** Correlation is significant at p<0.01 level; '-' indicate negative correlation; * Correlation is significant at p<0.05 level; WT: Water temperature; TRNS: Transparency; DO: Dissolved oxygen; TA: Total alkalinity; Ca: Calcium; CHL: Chlorine; NIT: Nitatre; PHOS: Phosphate; SIL: Silicate; BOD: Biological Oxygen Demand; COD: Chemical Oxygen Demand; PHYTO: Phytoplankton.

**Table 4**

**Percent Composition of seasonal distribution of different groups of phytoplankton in Balua Chaur during October 2008 to September 2009.**

| Phytoplankton classes | Post Monsoon 2008-09 | Pre Monsoon 2009 | Monsoon 2009 |
|---|---|---|---|
| Total Chlorophyceae | $24.40^{a} \pm 2.07$ | $19.89^{b} \pm 1.83$ | $28.74^{a} \pm 2.35$ |
| Total Cyanophyceae | $21.65^{b} \pm 1.87$ | $27.19^{a} \pm 2.41$ | $22.63^{b} \pm 2.18$ |
| Total Euglenophyceae | $37.63^{a} \pm 2.82$ | $39.03^{a} \pm 3.42$ | $33.28^{b} \pm 2.76$ |
| Total Bacilariophyceae | $16.32^{a} \pm 1.38$ | $13.33^{b} \pm 1.15$ | $13.35^{b} \pm 1.22$ |

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**Figure 1**

**Simple linear regression between phytoplankton density and transparency**

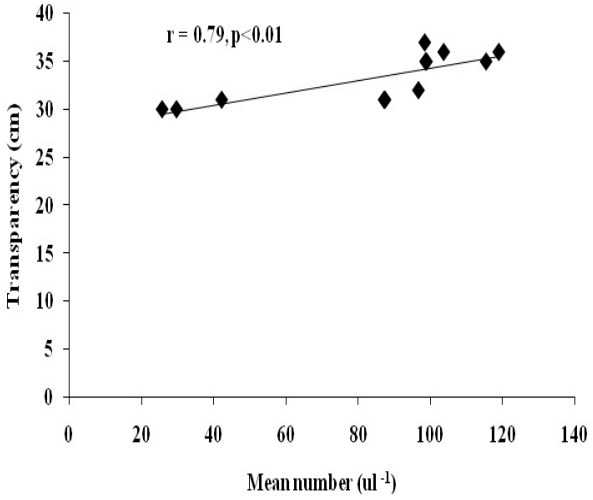
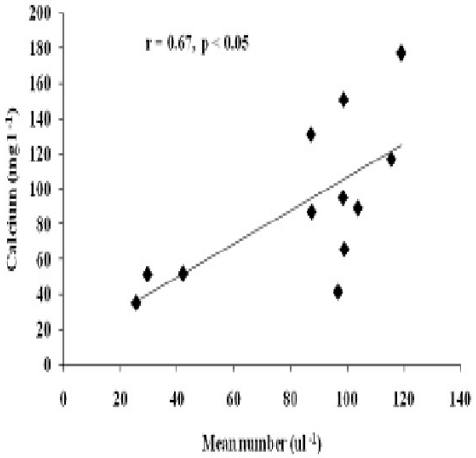



**Figure 2**

**Simple linear regression between phytoplankton density and calcium**

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